International Journal of Spatial Data Infrastructures Research, 2009. Vol. 4, 265-297

Assessing Spatial Data Infrastructure Policy Strategies Using the Multi-Actor Multi-Criteria Analysis*

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Abstract

Assessments of Spatial Data Infrastructure (SDI) strategies are rather scarce. When evaluations do occur, they usually cover only one aspect of a certain initiative or infrastructure, without taking into account all the other impacts it might have. Moreover, similar methods, such as the Cost-Benefit Analysis, are used in most situations. However, these techniques are only suited for very specific objectives as they require exclusively monetary information and they do not include the objectives or perceptions of the many relevant stakeholders of the SDI environment. This is why a new methodology for assessing SDI strategies is presented in this paper, namely the Multi-Actor Multi-Criteria Analysis (MAMCA). This technique is an extension of the original Multi-Criteria Analysis (MCA) and allows for structured and extensive stakeholder participation during the entire evaluation procedure. The methodology provides a new assessment framework that takes into account all the different criteria and actors of the complex SDI decision making context. In order to illustrate the opportunities and strengths of the MAMCA in the SDI context, a case study will be presented, where possible policy strategies for the SDI in Flanders will be assessed. In this paper, which forms the first section of a two-parted article, the methodology of the MAMCA method and its possible merits for the assessment of an SDI are illustrated, together with the first three steps of the case study. The second paper, which will be published at a later date, will document the four following MAMCA steps of the case study as well as its global results and possible future recommendations.

Keywords: Spatial Data Infrastructure (SDI), evaluation framework, decision-making, Multi-Criteria Analysis (MCA), Multi-Actor Multi-Criteria Analysis (MAMCA)

DOI: 10.2902/1725-0463.2009.04.art14

1 INTRODUCTION

Geographic data describe phenomena directly or indirectly associated with a location and time relative to the surface of the Earth (McKee, 1996). It has been estimated several times that more than 80% of the public sector information has a geographical component (Nevodic-Budic et al., 1999; Rajabifard et al., 2003). Hence, it is not surprising that billions of dollars are spent each year by organizations, agencies and departments of governments, the private and non-profit sectors and academics for the production, processing and use of spatial data (FGDC, 1997). To perform analyses and policy supporting studies based on these spatial data, Geographic Information Systems (GIS) are often needed. These are tools to store, manage and process digital spatial data (Rajabifard et al., 2003). However, a lot of problems arise with the creation, maintenance and use of these GIS. Since many datasets and information systems are developed in an isolated way, the accessibility and interoperability between them is often inadequate (Bouckaert et al., 2006). All over the world, various types of reference systems, software and databases are used, causing quality problems and content differences in the data. On top of these technical problems, there are also economic, organizational, legal and social elements that obstruct the seamless exchange, use and combination of data from different sources. Today, the Geographic Information (GI) community is trying hard to tackle these problems so that the integration of the individual systems can take place more fluently in the future (Bouckaert et al., 2006). Out of these initiatives it became clear that a structure, which comprises all the technical and societal aspects of the geo-enabled society, needed to be developed. This intent gave rise to the concept of the "Spatial Data Infrastructure", or in short, the SDI. There are many different ways in which one can define the SDI. This is because the concept might have different meanings, according to the country or the situation in which it is referred to. Moreover, the SDI is an evolving concept, causing the definition to change over the years. One can therefore not pinpoint a single exact definition (Grus et al., 2007) nor is it the aim to do so here. Rather, there are a lot of diverse descriptions of the concept, which have more or less the same meaning and/or contain the same building components. Also, a SDI is not an end in itself, but, as Rajabifard et al. (2003) define it, an initiative to create an environment in which all important stakeholders can cooperate with each other and use the appropriate technology to meet their requirements.

The problem is that all these stakeholders have various needs and wishes and thus might evaluate the same SDI differently. Unfortunately, some evaluation studies of SDI policy strategies do not take into account that the SDI is such a complex topic, which leads to the fact that the same assessment techniques, such as a cost-benefit analysis, are applied in most situations (see Longhorn and Blakemore, 2008). Furthermore, the focus of these studies lays often only on one

problem aspect and possible cross-impacts or perceptions of the stakeholders involved are not (properly) included. However, especially this latter aspect is extremely important since the ones that are best positioned to evaluate an infrastructure are precisely those that are confronted with it every day. According to Nedovic-Budic et al. (2008), it is the "use" of the infrastructure, and how that is experienced by the potential user, that determines the true success of the SDI. So only by investigating who the different users of spatial data are, what they are using the data for, and how the current SDI serves their various needs, one can assess if the SDI is truly doing what it was developed for. Moreover, SDIs are continuously expanding, becoming more complex and are concerning more people. Consequently, to perform in-depth evaluations, there is a clear need for a method that is able to integrate all these different aspects and actors at the same time in a structured and transparent way. This is why an evaluation approach is presented here that takes into account the elements mentioned above, namely the Multi-Actor Multi-Criteria Analysis or MAMCA developed by Macharis (2000). This is a tool able to support decision makers in their decision making process. It is an extension of the original Multi-Criteria Analysis (MCA) and just like these MCAs, it is able to include all the different aspects concerning a certain problem at the same time. The MAMCA goes even a step further as it has the additional value of incorporating all the relevant stakeholders together with their needs, whishes and perceptions during the entire evaluation procedure. These, along with other aspects that will be clarified further in this paper, suggest that the MAMCA may be an excellent tool for assessments and evaluations in the SDI context.

In the next section, the techniques and evaluation methods applied currently for assessing SDI policy strategies are illustrated, together with the problems they might cause. Afterwards, the Multi-Criteria Analysis methods in general and the Multi-Actor Multi-Criteria Analysis method in particular will be explained in detail. To illustrate the application of the MAMCA in an existing SDI context, the first steps of the SDI in Flanders case study are presented. To conclude, the basic ideas of this paper and the lessons learned from the first steps of this MAMCA case study will be summarized. Later on, in a second paper, the last steps of the case study and the final conclusions will be presented and discussed.

2 THE ASSESSMENT OF SDI POLICY STRATEGIES

Even though the awareness concerning the real meaning and impact of the SDI has increased, there are still many aspects that developers overlook when they plan an SDI activity. Those aspects may have technological, social, economic, legal or organizational roots, or even a combination of all of the above. Some attention points are, for instance, problems with data collection, different or contradictory metadata, pricing and funding issues, suitable education for employees, political forces, property rights or bureaucratic systems. These

aspects create problems on their own, but they also influence each other (Longhorn and Blakemore, 2008). Although nowadays the SDI community acknowledges the complexities in the different domains, all these issues are still tackled in a separate way, without taking into account cross impacts. However, governments and communities are becoming more and more aware of the fact that in-depth assessment of the economic and social impacts of a SDI is crucial for the future (Craglia and Novak, 2006).

In Europe, this way of thinking appears clearly from one of the requirements of the Directive 2007/2/EC for the establishment of an Infrastructure for Spatial Information in the European Community (INSPIRE). Following the extended impact assessment of the INSPIRE proposal (Dufourmont, 2004), a workshop organised y the Joint Research Centre of the European Commission on the state of the art in assessing SDIs, found that until then mainly ex-ante studies have been performed, most of the time to motivate funding requests. However, analyses need to be conducted regarding other aspects of the SDI as well during the entire lifespan of the SDI initiative. Furthermore, it is also essential to evaluate SDI policy strategies. By performing these strategy evaluations, the development of the SDI is monitored properly since decisions and new initiatives are taken in a thought-through manner and their presumed impacts on the SDI can be evaluated afterwards. A couple of methods and techniques can, and have been applied throughout the years to achieve these types of evaluations. Some of the well known and most applied methods are the Private Profitability (financial) Analysis, and the Social Cost-Benefit Analysis (SCBA). The first method is mostly applied by commercial organizations that aim at maximizing shareholders' wealth. More precisely, the technique may be used to find out if a certain project will be lucrative by comparing the incomes that the project will generate over its entire lifespan, with the amounts that need to be spent to start and maintain it. The SCBA for a certain project estimates the money value of all the benefits and costs, economic as well as non-economic, for all the members of the society. This stands in contrast to the first method that, most of the time, focuses only on the effects on one organization or firm (Craglia and Novak, 2006).

For the actual evaluation within these methods, several techniques can be used. An example of such a technique that is particularly suited for the Private Profitability (financial) Analysis is the Return On Investment (ROI) technique. With the ROI, a relative value, or ratio, is calculated by comparing the amount of money gained or lost with a certain initiative, relative to the amount of money that was invested in order to carry it out. An example of such a ROI study in the SDI context is presented in the "Geospatial Interoperability Return on Investment Study" of the NASA (Booz Allen Hamilton consultancy, 2005). For the SCBA, another technique is more appropriate, namely the Net Present Value (NPV). In this latter technique, the money values of the costs and the money values of the

benefits, of both economic and social/welfare aspects, are first discounted and then compared to each other. That way, the analyst is able to discover whether the initiative is desirable or not (Breesch, 2008).

Although these types of assessment methods may be very useful, particularly in the start up phase of a proposal, they are often too limited to lead to solid, comprehensive conclusions that take into account all the relevant aspects of a problem situation. The main reason for this shortcoming is that every cost and benefit needs to be quantified since the evaluation techniques of the ROI and CBA exclusively work with money values. However, in many situations, this obliged monetization might cause great difficulties since the impacts of a SDI initiative are often intangible, especially the benefits. For instance, which money value should be given to “higher reliability” or “more fluent decision making”, and how must one define these (Ayan, 2003). Not only is this procedure very difficult, it is subjective as well, since different actors may assign different values to the same objects or situations. This is certainly the case in the SDI context. As mentioned earlier, there are numerous people and organizations involved when it comes to SDI initiatives and they all view the situation from their own perspective. The end user might want high-quality information for little or no cost, whereas the data collector expects a compensation for his investments. The government would like to collect, use, and maybe even sell, geographic data and information, but the private sector might see this as a violation of the laws of fair competition. For a certain building project, the contractor might see the lucrative possibilities of a location at the countryside, while the insurance company is worried about flooding risks. These are just a few obvious examples to indicate that there is a definite need for assessments that account for all the costs and benefits, including the hidden and intangible ones, thereby bearing in mind that different stakeholders evaluate those effects in various ways.

Currently, many aspects overlooked, since it is impossible to give them a money value (Longhorn and Blakemore, 2008). Furthermore, a lot of initiatives are evaluated by specialized actors of a certain field. Since an expert always tends to look at the initiative according to his own background, the separate problems might get solved, but the combination of all of them will still be far from optimal. So, despite of the fact that the SDI in all its components gains importance, public interest and awareness worldwide, the need is very high for conducting more in depth studies concerning all the aspects of SDI initiatives and strategies. The implementation of a MCA or the MAMCA is a possible way to do this. In the next sections, these two methods will be explained in detail.

3 THE MULTI-CRITERIA ANALYSIS

A Multi-Criteria Analysis (MCA) or Multi-Criteria Decision Aid (MCDA) is a tool that is able to support decision makers in their decision making process by

providing clear and analytical information (Roy, 1993; Belton et al., 2002). It certainly does not replace the decision makers or draws conclusions for them, but it does offer very important information on all the impacts of a certain alternative or initiative. A strong characteristic of the MCA is that it allows the decision makers to take into account all the different known aspects of a given problem at the same time. Such a tool is crucial in our current complex society, where one single problem is surrounded by so many elements. Since it is known that a person can only deal with a certain amount of information at the same time (Miller, 1956), the MCA, which is able to combine all these elements in a structured and transparent manner, may be an essential tool for decision support. It presents the positive and negative aspects and impacts of a certain alternative and enables the decision maker to come to a judgment in a thorough and informed manner. There are numerous different types of MCA's. However, it is both undesirable and impossible to provide an exhaustive list in this paper. Some of the most known and popular MCA's are: the Analytic Hierarchy Process (AHP), developed by Saaty (1982), the Elimination Et Choix Traduisant la Realité (ELECTRE), developed by Roy (1968) and the Preference Ranking Organization METHod for Enrichment Evaluations (PROMETHEE), presented by Brans (1982). For a more complete and detailed overview of MCA methods, the reader is suggested to have a look at the work of Figueira et al. (2005). MCA has its roots in Operations Research (Charnes et al., 1961) but it can be applied in a wide variety of decision making problems ranging from the evaluation of transport projects, over the economic assessment of investment possibilities, location decisions and the building of a railway infrastructure, to the purchase of a car.

3.1 Introduction of the key concepts of a MCA

In the MCA, different alternatives get evaluated according to multiple criteria (Belton et al., 2002). An alternative may represent numerous things, such as a possible solution for a given problem, an initiative, a suggested policy strategy, a certain business process or anything else that one would like to investigate and evaluate. A criterion is a standard on the basis of which these assessments and comparisons can be made as it reflects an important aspect that needs to be taken into account when investigating the different alternatives. One can compare several alternatives according to one specific criterion, to see which one of the alternatives is the preferred option. If there are more criteria involved, which may be in conflict with each other, a Multiple Criteria Decision Making (MCDM) problem arises. When evaluating and comparing the alternatives, some criteria are more important to the decision makers than others. This is why different weights are usually assigned to the various criteria. This weight indicates how important that criterion is: the higher the weight, the more crucial the criterion and the more that criterion might affect the final outcome of the MCA. In the MCA procedure, the different alternatives obtain scores for each criterion. In order to be able to provide these scores, indicators and measurement methods need to

be established. They define the scales, methods and practical procedures that will have to be applied to evaluate the alternatives for each criterion. The indicators can be quantitative (like a price to measure a certain cost) as well as qualitative (like scoring “good”, “mediocre” or “bad” for a criterion). It is possible, and even common, that every criterion gets measured using a different indicator and measurement method. After an alternative is scored for each criterion separately, these scores need to be combined to obtain one total score for each alternative. These, rather mathematical, techniques that are used in this process are called aggregation methods.

In the next sections, the MCA will be explained in detail. First, the stepwise procedure of the MCA will be clarified. Afterwards, a classification of the different MCA methods is presented and finally some suggestions are given for choosing the most appropriate MCA method according to the specific objectives of the investigation.

3.2 Basic steps to conduct a MCA

Although there are a lot of different ways to conduct a MCA, the same basic steps appear in almost each method. A MCA is mostly built up out of two main phases, namely the construction or analytical phase and the exploitation or synthetic phase. Within these phases, there are several steps that need to be carried out to complete the MCA and come to a solution for the problem. Generally, six steps are distinguished, four belonging to the construction phase and two to the exploitation phase. Those steps usually get carried out in a chronological order as follows (Ampe et al., 2008; De Brucker et al., 1998; Nijkamp et al., 1990):

1. The analysis and definition of the problem
2. The generation of the different alternatives
3. The formulation of the criteria (together with their weights and indicators)
4. The construction of the evaluation matrix
5. The overall evaluation using an aggregation method
6. The integration of the results of the MCA in the true decision making process

In the first step, the analysts and decision makers analyze the problem. “Analysts” are people that are familiar with the context of a certain problem topic and that know how to conduct the different steps of the MCA. They are the ones analyzing the situation, performing the actual evaluation procedure and informing the final decision makers on the investigation and the outcomes. The “decision makers” or “policy makers” have the final control over the end decision, and they base their judgments on the results of the MCA. In this first step, the analysts and

policy makers examine all the connected aspects and possible impacts together and figure out which MCA method to use.

In the second step, the analyst tries to draw up a set of possible “alternatives” for the given problem. This group of potential actions, solutions or strategies is hardly ever complete, although the ambition is to make it as complete as possible. This set of alternatives may also change or be expanded during the further analysis.

The third step consists of creating the set of criteria. This set comprises all the relevant elements needed to evaluate and compare the different alternatives in a certain situation. There are a few methods available to generate the set of criteria in a structured manner (De Brucker et al., 1998). These techniques will not be explained in detail here, but more information can be found in Humphreys et al. (1975). When creating the set of criteria, two other important aspects need to be taking into account, namely the indicators and the weights for each criterion (Vertonghen, 1992). As mentioned earlier, the indicator points out the way in which the evaluation for the separate criteria will take place in practice. The weight of a criterion reflects how important that criterion is for evaluating and comparing the alternatives. There are many ways in which weights may be appointed; some examples are the trade-off method, the swing method, the rating method, the ranking method and the pair wise method. Extensive clarifications about these techniques can be found in De Brucker et al. (1998).

In the fourth step, the actual evaluation takes place and the evaluation matrix gets constructed. The analyst evaluates each alternative for all of the criteria and writes down the scores in a matrix with the alternatives as rows, the criteria as columns and the evaluations as elements of the matrix (De Brucker et al., 1998). The matrix provides a structured overview of the strengths and weaknesses of the different alternatives. However, it is not possible to come to a final decision based on the matrix in its original form. This is because the scores and numbers are all evaluations for different criteria and are thus based on various indicators. It is, for instance, not possible to directly compare the evaluation “good” to the score “500 Euro” or “7 people”. Moreover, the difference between “500 Euro” and “700 Euro” has another meaning than the difference between “good” and “bad”. A transformation or aggregation is thus required, to allow the analyst to draw conclusions out of the evaluation matrix.

This aggregation happens in the fifth step. The analyst can choose out of numerous aggregation methods to perform the analysis (a classification of these methods will be presented briefly in the next section). Depending on the chosen MCA method in the beginning of the analysis, the situation and the type of data in the evaluation matrix, the analyst chooses the most appropriate aggregation method. This fifth step is quite mathematical and can be carried out with or

without the help of appropriate software. In contrast to the information out of the fourth step, the results from the fifth step may be used to come to a final conclusion. Depending on the chosen method, a “ranking”, “choice”, “sorting” or “description” of the alternatives is available for further investigation. As mentioned earlier, the MCA does not deliver a fit-to-use solution and certainly does not replace the decision maker, but it might provide very useful information for developing a policy strategy in a profound and documented matter.

In the sixth and last step, all the information out of the MCA (the final result, but also the indications out of all the other steps) gets incorporated in the eventual decision making. One must keep in mind however that the satisfying result is not always reached straight away. It is possible that the end result or even some intermediate results are not satisfying to the analyst or the policy makers. At that point, it is always possible to restart certain steps of the analysis or even the whole procedure. The fact that the MCA may be carried out iteratively creates great advantages, especially in problem situations that are not entirely clear from the start.

3.3 Classification of MCA methods

There are many, varying techniques which may be used to conduct a MCA. Already in 1983, Despontin et al. described more than a hundred different MCA-techniques (Despontin et al., 1983). Since then, the number of developed and applied methods continued to rise (Figueira et al., 2005; Belton et al., 2002). To obtain more structure and to create higher user friendliness, some efforts to categorize these methods have been made.

One way to classify MCA’s into groups is by looking at the aggregation method that is applied in the procedure. As mentioned before, an aggregation method is a way in which the separate evaluations of the alternatives for the different criteria are combined in order to compare the total score of one alternative to that of the others. Based on this characteristic, three major methods may be distinguished, namely “complete aggregation”, “partial aggregation” and “iterative or interactive aggregation” (Ampe et al., 2008; De Brucker, 1998; Roy et al., 1993; Nijkamp et al., 1990).

It is also possible to classify the MCA methods based upon their underlying school of thought. This classification is actually quite similar to the one based on the aggregation technique. This is because certain schools of thought converge partly, though not necessarily, to the three types of aggregation techniques mentioned above (Ampe et al., 2008). According to Roy et al. (1996), there are four different schools of thought, which are based upon different notions and often criticize and contradict each other, namely (1) the American school, based on utility functions (2) the European or French school, based on outranking

methods (3) the school of the interactive methods and (4) the school of the goal programming methods. An elaborate clarification of these schools of thought is beyond the scope of this paper, but the interested reader is referred to Figueira et al. (2005) and Vertonghen (1992) for more information on this subject.

3.4 Choosing the most appropriate MCA method

Although nearly all MCA methods are designed to deal with a great variety of problems, it is clear that, in practice, some methods are more suited for certain problems than others (Tsamboulas et al., 1999). There is no such thing as a "super method", since all of them have positive as well as negative points. Moreover, the MCA technique in itself is not flawless. According to Tsamboulas et al. (1999), there are two main shortcomings connected to the general MCA technique. The first one is related to the fact that there are so many criteria, which most of the time even conflict with each other. Therefore, there is no available solution that optimizes all the criteria at the same time. This is why the decision maker will have to be satisfied with a compromise solution. The second shortcoming is associated with the dominance relations that are not always totally clear. One alternative may score high on a certain set of criteria and low on another, while a second alternative may do just the opposite. This leads to an incomparability and uncertainty about the preferred alternative.

Nonetheless, the MCA is an exquisite way to tackle a complex problem without losing sight of all the different and crucial aspects. However, the power of the MCA increases or decreases with the choice of the MCA technique. The analysts will have to choose the most appropriate method according to the type of the problem and the situation. This is not always a simple task and it might even be considered as a multi-criteria problem in itself. Several authors devoted their attention to working out procedures for choosing the most suited MCA method according to the problem situation. There are some elements that are recurrent in those different guidelines, such as the type of the problem, the type of available information, the characteristics of the decision maker, the acceptability of the MCA method and its consistency (Ampe et al., 2008; Macharis, 2000; Tsamboulas et al., 1999; Guitoni et al., 1998; Tecle et al., 1990).

Perhaps the most important criterion of the ones mentioned above is the type, the nature of the problem that needs to be solved. According to Roy (1996), there are four types of decision problems that may be distinguished, namely the α, β, γ and the less known δ- type. An α-problem is a selection or "choice" problem. In this situation, the decision maker wants to select one optimal alternative out of a couple of possibilities. This alternative is the one that has the best overall score on the predetermined criteria. In the β-type, or "sorting", the goal is to order the alternatives in a few different groups. The decision maker is no longer only

interested in "the winning" alternative, but he/she wants to place all the possibilities in groups with certain characteristics (for example "good", "average" and "bad" or "accepted", "maybe accepted" and "not accepted"). The γ-type, or "ranking", will rank the different alternatives from the most preferred option to the least. The difference with the β-type is that the alternatives of the γ-problem first get divided into a lot of categories, which were not stipulated in advance, afterwards, they get ranked within their own category. The δ- type or "description" does not deliver a complete solution for the investigated problem, but offers a detailed description. No ranking, sorting or optimal choice is presented, since the methods of the δ- type do not go beyond the completion of the evaluation matrix. However, based upon the information out of that matrix, and a detailed description of all the preceding steps and the alternatives, the decision makers can proceed their investigation in a well informed manner. Since the δ- type does not offer a true evaluation, it distinguishes itself greatly from the other types (Ampe et al., 2008; Vertonghen, 1992).

If the experts and decision makers are aware of the type of the problem they want to investigate, the number of possible MCA techniques is narrowed and the selection of the most appropriate one is less difficult.

4 THE IMPORTANCE OF STAKEHOLDER PARTICIPATION

As indicated above, a MCA is able to integrate simultaneously a great amount of conditions, effects and impacts that surround a certain problem situation. Nevertheless, to make a truly underpinned decision, another very important factor has to be taken into account, namely the human factor. Despite of the fact that the MCA already has many added values compared to the methods that are usually applied for evaluating SDI initiatives or strategies, it fails to take into account this human factor as well. This is why one must search even further and find a technique that is able to abolish this flaw. In this context people that play a crucial role in a certain decision making context are referred to as "stakeholders". According to Freeman (1984) a stakeholder is "any individual or group of individuals that can influence or are influenced by the achievement of the organization's objectives". Or, as Banville et al. (1998) put it: "stakeholders are those people who have a vested interest in a problem by affecting it or/and being affected by it". Depending on the problem that needs to be analyzed, different stakeholders might occur. Also, if the situation is complex, many stakeholders need to be taken into consideration to create an adequate decision-making forum. Since these people or groups have various backgrounds, they all look at a given problem from their own perspective. Take the price of a consumer good for example; the producer will try to maximize the price and minimize the material costs, whereas the consumer wants to pay as little as possible for a high quality product. The difficulty lies exactly in the combination of all those different needs

and wishes. However, the inclusion of the stakeholders and their interests is necessary to avoid that the final decision is ignored or even obstructed by them (Walker, 2000). In particular, when the analyst expects the result of his/her analysis to be controversial or when he presumes that the acceptance rate might be low, stakeholder participation is required (Walker, 2000). Besides, it is impossible for the analyst to determine all the possible impacts of a problem on his/her own, which is yet another reason for stakeholder participation.

However, the degree of participation may vary from one problem situation to another. One must bear in mind that involving the stakeholders in the decision process costs a lot of time, effort and money. Moreover, some people will not want to cooperate although they might be connected to the problem. It is also possible, when group meetings occur in the process, that one persuading member or a powerful group influences all the other stakeholders, which leads to distorted outcomes (Macharis, 2000). For the reasons mentioned above, stakeholder participation is required, but needs to be organized and structured with care.

Recently, the concept of stakeholder participation started to get more attention in general and also in the MCA context (Ampe et al., 2008; Ondrus et al., 2006; Macharis, 2004; Bana e Costa, 2001). Earlier, true stakeholder participation was hardly ever a part of the MCA methods, let alone that it was a structured element of the analysis. Nonetheless, a MCA may be a very useful tool for the introduction of stakeholders (Banville et al., 1998). There have been some attempts to incorporate stakeholders in certain MCA's, such as in PROMETHEE, ELECTRE and AHP. To achieve this, the methods needed to be adapted and an additional layer in the analysis needed to be developed. Because several decision makers are consulted during the analysis, those extended methods received the name "Group Decision Support Systems" (GDSS). They are also referred to sometimes as the second generation of MCAs. An example of such GDSS can be found in Macharis et al. (1998). However, the concept of stakeholder participation was not truly defined nor was it structured in these GDSS. Banville et al. (1998) introduced a first structured framework and suggest consulting the stakeholders in the first three stages of the MCA, namely the analysis of the problem and the formulation of the alternatives and criteria. However, in the following steps, they no longer mention stakeholder participation (Macharis et al., 2008b). In order to provide an answer to these shortcomings, the MAMCA was developed, which does incorporate the stakeholders during the whole analytical process in a structured way. This continuous cooperation of the stakeholders is very important in the context of SDI decision making for various reasons. As mentioned above in this section, stakeholder participation is crucial for a higher acceptance rate at the end of the analysis since the more the stakeholders are involved, the more they will understand, influence and accept the final outcome. Moreover, when the analysis is not going in the right direction according to them, they can

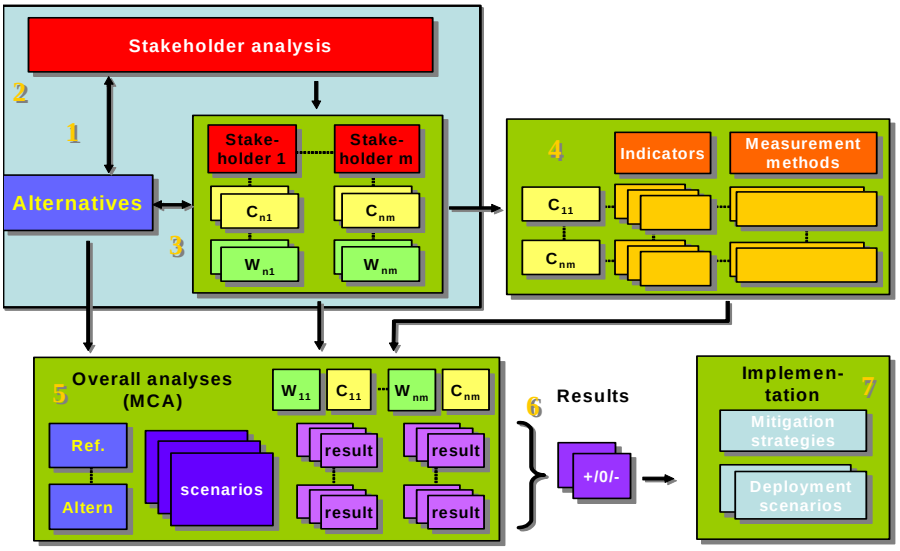
immediately alert the analyst who can consequently restart some steps or the whole procedure. That way, the iterative nature of the MAMCA is fully exploited. Obviously, the analyst can not be an expert of all the aspects concerning the SDI problem situation; if he/she has the possibility to address stakeholders of various domains at any time during the procedure, the evaluation process will be more correct and complete, leading to a more realistic result in the end.

5 THE MULTI-ACTOR MULTI-CRITERIA ANALYSIS

The procedure of the MAMCA may also be subdivided into a number of steps, which are sometimes similar to those of the original MCA, though certainly not equal, since stakeholders play the leading role in the MAMCA. In total, there are seven steps (instead of six for the MCA) and most of them include stakeholder participation in one way or another. In this section, the focus will lie on those steps of the procedure that require the most stakeholder participation and thus differ from the original MCA steps. Details about the other aspects may thus be found in section 3.2.

In figure 1, a diagram is presented that summarizes the seven steps of the MAMCA explained above.

Figure 1: Methodology for a Multi-Actor Multi-Criteria Analysis (MAMCA)
Source: Macharis et al., 2004



In the first step, the problem is analyzed and defined and the construction of the set of alternatives is completed.

The second step consists of the stakeholder analysis. The analyst conducts a thorough investigation to find out which stakeholders need to participate in the future analysis. Also, he/she investigates the wishes, needs and objectives of the different stakeholders or stakeholder groups. The first two steps may be carried out iteratively, since the stakeholders might also propose additional alternatives. This second step is of major importance for the rest of the MAMCA procedure since the inclusion or exclusion of specific stakeholder groups will affect the end results greatly. It is thus very important that the participating stakeholder groups are chosen conscientiously. This step represents the largest difference between the MAMCA and the original MCA.

Based on the information from the stakeholders, the set of criteria is being formulated in step three. This is because, in a MAMCA, the criteria are almost a direct translation of the aims and objectives of the stakeholders (this in great contrast to the determination of the criteria in the traditional MCA). In the third step, the weights of the criteria are also determined. Those are derived from the relative importance that the stakeholders assign to their various criteria. For the allocation of the weights, one of the methods mentioned in section 3.2 may be utilized. There is an additional aspect in the MAMCA that does not occur in the regular MCA, namely the weights of the stakeholders themselves; the so-called “inter-stakeholder” weights. It is thus possible to allocate different weights to the various stakeholders. Depending on their presumed importance and relevance to the given problem, a higher or lower weight may be assigned to certain people or groups. However, most of the time, no inter-stakeholder weights are allocated, to indicate that all the stakeholders are equally important. At the end of the analysis, it is still possible to discover what would happen with the final result if one stakeholder or group would be seen as more important than another. This can be done with a so called sensitivity analysis, where the weights of the different stakeholders are modified and the analyst looks at the effect that this has on the final result. It is also possible not to assign weights, but to choose the option that scores the best for the objectives of one specific or central stakeholder group, for example the government or the society. The information out of all the other criteria can then be used to estimate what the influences of that specific alternative will be on the other stakeholder groups.

In the fourth step, an indicator is chosen for each criterion. The analyst defines how the different alternatives will be evaluated for the criteria, which scales will be used, whether the information will be quantitative or qualitative and which procedure shall be followed.

The actual overall analysis takes place in the fifth step. Each alternative obtains scores for all the criteria measured by the indicators established in step four. For this evaluation, one of the MCA methods mentioned earlier in this paper can be

used (such as PROMETHEE, ELECTRE or AHP). Depending on the given problem, the type of information, the desired result and the preferences of the analyst and the stakeholders, a certain method is picked out.

In step six, the actual results of the analysis become clear. Depending on the method used, a description, ranking, sorting or recommended choice is presented. This does not have to be the final outcome though. The analyst can perform a sensitivity analysis by changing the weights of the criteria or the stakeholder groups to find out how those adjustments influence the result. Also, it is unlikely that this result of the MAMCA is a fit-to-use solution to the problem. Just as with another MCA, the aim is especially to create a better insight in the problem and to provide clear information to the decision maker so that he/she can make an underpinned judgment.

In step seven, the results of the MAMCA are further investigated. Certain alternatives might be used directly or are fitted into the policymaking process. It is possible that, based on the information out of the MAMCA, additional alternatives, or adaptations of the original alternatives, emerge and then the MAMCA might even start all over again until the desired results are achieved (Macharis et al., 2008a; Macharis, 2007).

6 APPLICATION OF THE MAMCA IN THE CONTEXT OF SDI IN FLANDERS

A well functioning SDI requires the cooperation between numerous people and organizations. If the policymakers want to support, maintain and further develop this SDI, they have to take into account the different objectives of all the involved stakeholders. Since the SDI is such a complex subject and the objectives of the stakeholders are often completely contradictory; policy strategies should be developed in a structured and well considered manner. Thus, aside from disciplinary analyses, a multi- and interdisciplinary research needs to be performed that takes into account all those important aspects. The MAMCA may be the ideal way to achieve this since it provides a framework that allows for the structured integration of all the relevant elements and involved stakeholders of the SDI problem context. It is important to know that the final as well as the intermediate results of the MAMCA generate very useful information for the final decision maker.

The first steps of the case study concerning the policy strategy assessment of the SDI in Flanders, will be presented in this paper to illustrate how the MAMCA can be implemented. In the second section of the two-parted paper, the next steps and final results will be shown and it will be clarified what the merits of the MAMCA may be when applied in the SDI context. The focus of the entire procedure will lie on the application of the MAMCA to assess possible SDI policy

strategies in Flanders. In this paper, the first three steps of the MAMCA procedure are clarified. The extensive illustration of these three steps is essential, since they create the framework of the entire analysis.

However, before clarifying the case study, a brief introduction to the SDI in Flanders will be provided. That way, the reader is able to contextualize the different steps of the MAMCA in the current situation and developments of the SDI in Flanders.

6.1 Developments of the SDI in Flanders

Already in 1995, Flanders started to set up a framework for cooperation to develop and implement a sound communication and management system for geographical information: GIS-Flanders. Many stakeholders have taken part in the development of GIS-Flanders including all the departments of the Flemish government, the Flemish public agencies (e.g. environmental agency, land agency, institute for nature conservation, etc.), the provincial authorities and the municipalities.

The key results of GIS-Flanders so far are the supply of data and services and the adoption of (interoperability) standards. One of the main objectives of GIS-Flanders is distributing spatial data in a vendor-independent context and, by doing so, systematically supporting the most frequently used data formats. More than 50 full coverage datasets are available, including: Street network, Flemish Hydrographical Atlas, Ortho-photos, Cadastral parcels, Digital Elevation Models, and Soil maps. In addition, several web services have been developed. Examples of developed services are: Geo-Flanders (http://geo-vlaanderen.agiv.be) serving visualisation and querying tools; GIRAF (http://www.giraf.agiv.be) allowing spatial data editing, ordering, and downloading of the available data; FLEPOS (http://www.flepos.be), for the Flemish Positioning Service for GPS measurements; KLIP (http://www.klip.be) monitoring digging and excavation requests to prevent damage to subsurface utility lines; and CRAB (http://www.agiv.be/gis/projecten/?catid=34) for the exchange of address information. The standardisation efforts have resulted in the acceptance and use of data made available by GIS-Flanders, as the single reference source for new datasets throughout Flemish public authorities. The common usage of agreed specifications, services, and recommendations makes, for example, the technical exchange of data feasible.

The cooperation framework GIS-Flanders forms the backbone of the SDI in Flanders. From a recent study (SPATIALIST, 2009) it appears that the strengths of the SDI in Flanders are the following: the single reference source for datasets, the high availability of spatial data, and the strong data uniformity. The main

weaknesses are the poor actualisation of core datasets, the time-consuming pre-processing activities and the lack of coordination.

In the ambition to make Flanders one of the top regions in Europe by 2020, the Flemish government considers the development of SDI as one of the key factors for success (Vlaamse Overheid, 2009a). The Flemish government has also formally agreed that the SDI in Flanders has to be improved during the period 2009-2014 in order to contribute to a more transparent and innovative government (Vlaamse Overheid, 2009b). Another milestone is the recent approval of the decree concerning the SDI in Flanders by the Flemish parliament (Flemish parliament, 2009), which forms the base to transpose the INSPIRE-directive into the Flemish legal framework.

Based on the achievements of GIS-Flanders, the INSPIRE-requirements and the objectives set by the Flemish government, different activities are planned. These include: transforming the INSPIRE-directive into Flemish law and arranging the commitments among the involved stakeholders, setting up proper organisation and coordination structures, developing a communication structure and communication plan, designing the technical infrastructure for disseminating spatial data using meta data, building the Flemish geo-portal, harmonising spatial datasets and metadata, improving the accessibility and use of spatial datasets, supporting the involved stakeholders, monitoring and reporting the objectives, participating at the preparation activities of the INSPIRE implementing rules and setting up a financial budget plan. For more detailed information about these future activities, see Depredomme and De Temmerman (2009).

6.2 Defining the problem and building the set of alternatives

The first step of the MAMCA consists of the problem definition and the building of the set of alternatives. The central topic and, at the same time, the main objective of the analysis is assessing and comparing possible SDI policy strategies for the SDI in Flanders. Or formulated in other words: which future policy options must be chosen to further develop, operate and maintain the SDI in Flanders so that it fulfils the different demands of the stakeholders involved in the best possible (compromising) way and so that an effective, efficient, flexible and feasible geographic society can emerge? Out of this main intention, all the other steps of the MAMCA are derived. For instance, there exists a very clear link between the problem definition and the set of alternatives. The alternatives reflect the possible policy strategies the government may follow, to manage and further develop the SDI in Flanders. In this case, an α-problem type (mentioned in section 3.4) is studied, since the objective is to select the best overall scoring alternative out of a couple of predetermined possible alternatives. This “best” alternative will never be optimal for all the stakeholders since it is impossible to satisfy all their

different, and sometimes even contradicting, needs and wishes at the same time. The MAMCA will thus suggest the best compromising SDI policy strategy.

It is very important to describe the alternatives in a concrete and unambiguous way. This is crucial for the future decision making that might be based on the evaluation and comparison of these various alternatives. In this context, the alternatives are strongly based on three dominant approaches for coordination in the public sector (as well as in other sectors), namely the “Hierarchy, Market and Network” or “HMN” mechanisms. These three procedures are generally known and reoccur in studies and literature numerous times, as for example in O’Toole (1997) and Thompson et al. (1991). Since the aim of the MAMCA in this context is precisely to compare and assess possible policy strategies for coordinating and managing an infrastructure by the government, the application of these HMN procedures might be very useful. Not only do they occur, separately or combined, in each level of the public sector, they are also very different from each other and comprise specific strengths and weaknesses for coordinating projects and maintaining infrastructures. This characteristic is exactly what makes them so suited and interesting for the application of the MAMCA. Although there is no single definition for these coordination methods, and each form has its own sub types, some features seem to be typical for a different approach, which creates a clear distinction between them (Thompson et al., 1991).

The hierarchy mechanism is primarily based on authorization. In hierarchically organized situations, there generally exists one branch in the system that controls and lays down the rules for all the other divisions. Usually, the government is the institution that moderates the whole system by using top-down decision making. There are clear standards, norms, routines and procedures that are stipulated in advance and need to be followed by everyone. The different departments and organizations all act independently but are guided by certain rules. The keywords are authority and dominance. The market mechanism is based on totally different objectives. In those systems, exchange and competition are the most important aspects. The different organizations bargain with each other, all of them principally guided by their own self-interest. Economic concepts such as “the invisible hand”, price mechanisms and demand and supply, play an important role in the market structure. The government acts more as a watch dog for the well functioning of the market than as a commander of the whole process. In the last type, the network coordination system, the cooperation between the different actors is based on mutual interests, trust and the allocation of responsibilities. Agreements between various partners are formulated during intensive conversations in which loyalty, consensus and compromise are the key success factors. The government does not control or regulate, but acts as a manager of the relations or sometimes as one of the participants (Verhoest et al., 2005).

The alternatives for the case study of the SDI in Flanders are strongly based on these three coordination approaches. The general HMN mechanisms were placed in the SDI in Flanders context and out of this, three different alternatives emerged. The legal, organizational, public-administrative, economic and technical characteristics of these alternatives are listed below:

- *Alternative 1: the hierarchy strategy*
  - Strict, comprehensive legislation; clear-cut contracts
  - Functional division of labour; top-down decision making
  - Central policy preparation and policy making; central implementation of tasks; data and tasks are produced and processed internally; no, or strictly regulated, exchange of data between different stakeholders
  - Predetermined and fixed prices imposed by the government; implementation of specific price setting mechanism; predetermined funding budgets; division of budgets according to specific departments or tasks
  - Fixed standards, imposed by the government; one central data provider which supplies data sets, meta data, network services, tools and applications; specific standards are imposed centrally; central technological infrastructure

- *Alternative 2: the market strategy*
  - Ad-hoc agreements; flexible and adaptable legislation; few contracts and laws; few obligations
  - Outsourcing; market-driven relations; independent departments within the government; negotiations between different sub-departments
  - Shared central and sub-central policy preparation and policy making; shared tasks; outsourcing of government tasks to the private sector; market driven coordination mechanisms; selling and buying data and information
  - Prices are determined by the laws of demand and supply; flexible prices per stakeholder, application, time; fixed total budgets, divided based on negotiations; financial sources are also acquired externally through various market activities
  - Improvements of the technological infrastructure are handled by the market; databases, metadata, standards, applications and network services are developed and regulated by market mechanisms

- *Alternative 3: the network strategy*
  - Little or no laws, legislation, or contracts; informal exchange of data, information and services; mutual agreements

- Flexible division of labour that may be adapted according to the situation; mixed services, people doing various tasks; cooperation; negotiations; shared goals
- Sub-central policy preparation and policy making; both complete internal completion of tasks as outsourcing; interest and need for cooperation between public and private sector; jointly processing and exchanging of information
- Free information or barter; free access; few rules and regulations; budgets are distributed or demanded according to needs; common projects funded by common budgets
- Jointly maintenance and improvements of the infrastructure, based on the consultation of various the stakeholders; shared responsibilities; exchange or jointly creation of databases and metadata; applications and network services are developed based on common needs and wishes

These detailed descriptions of the HMN strategies, adapted to the SDI context, are not only important for a correct start of the MAMCA but are crucial during the further analysis as well, particularly at the moment of the actual evaluation. If one desires to evaluate alternatives according to the set of criteria, it is essential to understand their full meaning. Also, at the very end of the analysis, when the results are being incorporated in the policy making procedures, there may not be any doubt about the proper meaning of the alternatives. However, the different policy options described above may or may not be possible to implement in their totality. Most likely, none of the alternatives will prove to be the ultimate alternative to implement for the further development of the SDI in Flanders. This is because all of them have strengths as well as weaknesses. Moreover, they are, in their current forms, rather extreme and therefore not intended for an integral and non-modified application in an existing SDI environment. This is especially true since, as mentioned above, the SDI in Flanders has been evolving since 1995. Many working methods and contracts are already in use and a legal framework has been built up throughout the years. These elements are often very robust and it will take a long time, or it might sometimes be impossible, to remove or even transform them. However, this can not imply that the current framework may not be challenged or questioned. To preserve a healthy and up to date infrastructure, the current environment needs to be evaluated continuously. So, although the alternatives proposed in this paper may not be totally realistic, they will be able to show where the flaws are situated in the existing SDI. Therefore, they might indicate where extra efforts, changes and inputs are required; even if they will only lead to results years from now. Moreover, this case study is not an exception, since the aim of the MAMCA is not per se to provide fit-to-use policy solutions and answers for all the problems encountered in a certain situation. Rather, the application of the MAMCA presents the pros and cons of the different alternatives to the policy makers in a structured way and is aimed at supporting them in their final decision making procedure.

6.3 The stakeholder analysis

In order to start the stakeholder analysis, the analyst needs to identify all the people, groups or organizations that influence, or are involved in the SDI in Flanders. Obviously, it is both impossible and undesirable to include all of these stakeholders into the MAMCA procedure. The analyst must therefore select exactly that combination of stakeholders that is able to represent the SDI society in its totality. In the case of the SDI in Flanders, those significant stakeholders are classified into four basic groups based on the roles they fulfil in the SDI context. The four groups are (1) the government, (2) the private sector, (3) the utility sector and (4) the citizens together with the Non-Governmental Organizations (NGO's). The first group is the most important one since it is the government that has to take the final policy decisions based on the information from the MAMCA. However, the government must do so, taking into account the objectives of, and effects on, all the other stakeholders in order to decide on measures that are better attuned to the society as a whole. To present a realistic picture of the effects the alternatives have on the whole SDI society, it is crucial that the other three stakeholder groups are considered in the analysis as well.

The "government" remains the central and most important stakeholder group during the entire procedure since the end results of the analysis are aimed at supporting them in their policy making procedures. The results and recommendations that follow out of the MAMCA need to be communicated to the government in a clear and documented manner by the analysts. Consequently, the analysts have the most frequent and intense contacts with the actors of this stakeholder group. For the reasons mentioned above, this stakeholder group is represented by a large group of actors. However, these actors have various backgrounds, occupations, perceptions and thus also objectives, which makes it impossible to come to a distinct set of criteria for this stakeholder group in its current composition. Therefore, subdivisions are made based on the different functions of the actors within the SDI network, which are in parallel with the natural flow of data processing. There are three general processes, and thus subdivisions, to be distinguished, namely data production, data processing and data utilization. The actors that relate to each of these processes have various needs and objectives, which is exactly what is required to perform the MAMCA. From various layers of the government, different actors are appointed that represent producers, processors or users.

For the stakeholder group "private sector" the same subdivisions could have been made. However, the subgroups private producers and private processors were deleted, so that only the group private users remained. The first two groups do exist in practice, but they are less relevant for this case study. After all, the government is the central stakeholder group and the focus lies on the

relationships between the members of the private sector and the government. Therefore, the activities within the private sector or those of the private sector as a data producer go beyond the scope of this case study.

The group “utility sector” is included in the MAMCA since it is such an important player of the SDI in Flanders and has aims and objectives that are very different from those of the other stakeholders. Moreover, the members of the utility sector have a special relationship with the government since they do not only use much data from the government but are data producers themselves as well. Consequently, one can speak of exchange flows and the utility sector functions as a producer, a processor and a user. However, the objectives of these last three functional groups within the utility sector are not so very different and may easily be combined into one main group. In this case study, the focus lies on the use of the data from, and the exchange with, the government. Therefore, no subdivisions are made in this stakeholder group.

The last stakeholder group is the one of the “citizens & NGOs”. As with the groups “private sector” and “utility sector”, also only one part of the data chain is studied in detail, namely the end use and the relations with the government. This stakeholder group consists of actors from the citizens and the NGOs, which are both very important in the SDI in Flanders context. Since they have similar needs and objectives, it is decided to structure them in one group.

The objectives of all the other people and groups that influence or get influenced by the SDI, can be recognized in one of the four groups mentioned above. These four stakeholder groups thus represent the SDI community in its totality. In consequence, there are four main groups of stakeholders, namely the private sector, the utility sector, the citizens together with the NGOs and the government. The last group has three subdivisions, namely the producers, the processors and the users of data within the government. An overview of the stakeholder groups may be found in table 1; the “X’s” represent a stakeholder group that is not specifically considered in this case.

Table 1: Different stakeholder groups of the SDI in Flanders

	Data production	*Data processing*	*Data utilization*
Government	**Data producers**	**Data processors**	**Policy makers**
Private sector	X	X	**Private sector**
Utility sector	X	X	**Utility sector**
Citizens / NGO’s	X	X	**Citizens & NGO’s**

Another important aspect needs to be considered when completing the stakeholder analysis, namely the weights that are assigned to the different groups. In this case study, the key stakeholder group is clearly the government. The three other groups are important as well, but the main reasons to include them are to investigate their relationship with the government on the one hand (their perceptions of the current situation, expectations towards the future and their attitude towards various policies), and to create a realistic reflection of the SDI environment in Flanders on the other hand. However, the major importance of the government must be made clear in the analysis. One way to do this is by assigning a higher weight to the group government. However, in this case study, a second option is chosen, namely the performance of a sensitivity analysis in the end, in which the weights of all the groups may be modified. In this way, the decision makers can see the repercussions on the end results of, for example, allocating a higher weight to the government.

6.4 Building the set of criteria

In order to make the transition from step two to step three, the analysts need to find out what the objectives of the different stakeholder groups are. Only then, a set of criteria can be constructed in the MAMCA. To figure out what the requirements and points of interest of the stakeholders are, different techniques may be applied. In this situation, a combination of some of those techniques is used. First, some organizational visits are carried out with key actors representing the different stakeholder groups. In this way, the analysts and the stakeholders can get acquainted and some first ideas may be exchanged. The stakeholders explain their working processes, their experiences with the current SDI and their wishes or fears towards the future. Secondly, the analysts carry out literature studies to find out which criteria seem to matter for the different players in SDIs in Flanders and elsewhere in the world.

Thirdly, a questionnaire is distributed to different organizations and people of various domains and layers of the “SDI landscape”. The overall goal of this survey is to get a clear picture of the current situation of the SDI in Flanders by questioning specific characteristics of some data flows, investigating the interactions between the various actors and discovering their perceptions about the SDI. The survey consists of three major parts. The first part contains informative questions to discover the basic characteristics of the participating organizations. In the second part, the questions are focused on four specific data flows (parcels, roads, addresses and hydrographic datasets) and the features of the different associated data relations.

In the final part, the survey goes beyond the clear-cut facts and tries to question the perceptions and objectives of the organizations concerning the current SDI society in its totality. Particularly this final part provides very important and useful

insights for the MAMCA since it are exactly the perceptions and objectives of the stakeholders that are crucial for developing a set of criteria. In concrete, the respondents have to state what they consider to be the strengths and weaknesses of the current SDI in Flanders. To do so, they are asked to fill in two questions. In contrast to the first two sections of the questionnaire, where the answer categories are predefined, the questions in this final part are open. This way, the respondents are free to pinpoint those aspects that matter the most to them. In addition, they are asked to divide a total sum of 100,000 euro over twelve SDI related activities so that the analysts can get an idea of the stakeholders' (investment) priorities concerning the SDI. In the end, 219 entirely filled in questionnaires are received out of a total of 462, adding up to a response rate of 47.4%. Afterwards, some additional in-depth interviews with key organizations or persons are organized to fill in important missing blanks. The questionnaire is included in annex 1 (see IJSDIR web site[1]).

Out of the first question, the elements that the respondents value and consider as strengths of the SDI in Flanders become clear. Most appreciated is the vast supply of geographical data that Flanders provides. Other plus points are the central data provision, the accessibility to data and the uniformity of the different data. Aside from these strengths, some weaknesses are also pointed out by the stakeholders in the second question. The negative element that is mentioned the most, by far (25% of the despondences), is the poor actualization of data. A lot of the data that the stakeholders need is not up-to-date (e.g. cadastral datasets). Sometimes certain steps of procedures, that need to be completed to acquire the data, are so complex and elaborate that the required data are not received when needed or already outdated to start with. Another problem encountered by the respondents is the feeling that there is a lack of harmonization between the different players of the SDI in Flanders, for instance, the lack of coordination and collaboration between the Flemish and Federal governments. A consequence of the two latter aspects is that many modifications are needed before the data can be used, which is also considered to be a weakness of the current infrastructure. Other negative points mentioned by the respondents are the lack of capacity to fully exploit all the advantages of geographical information and the limited accessibility to certain datasets.

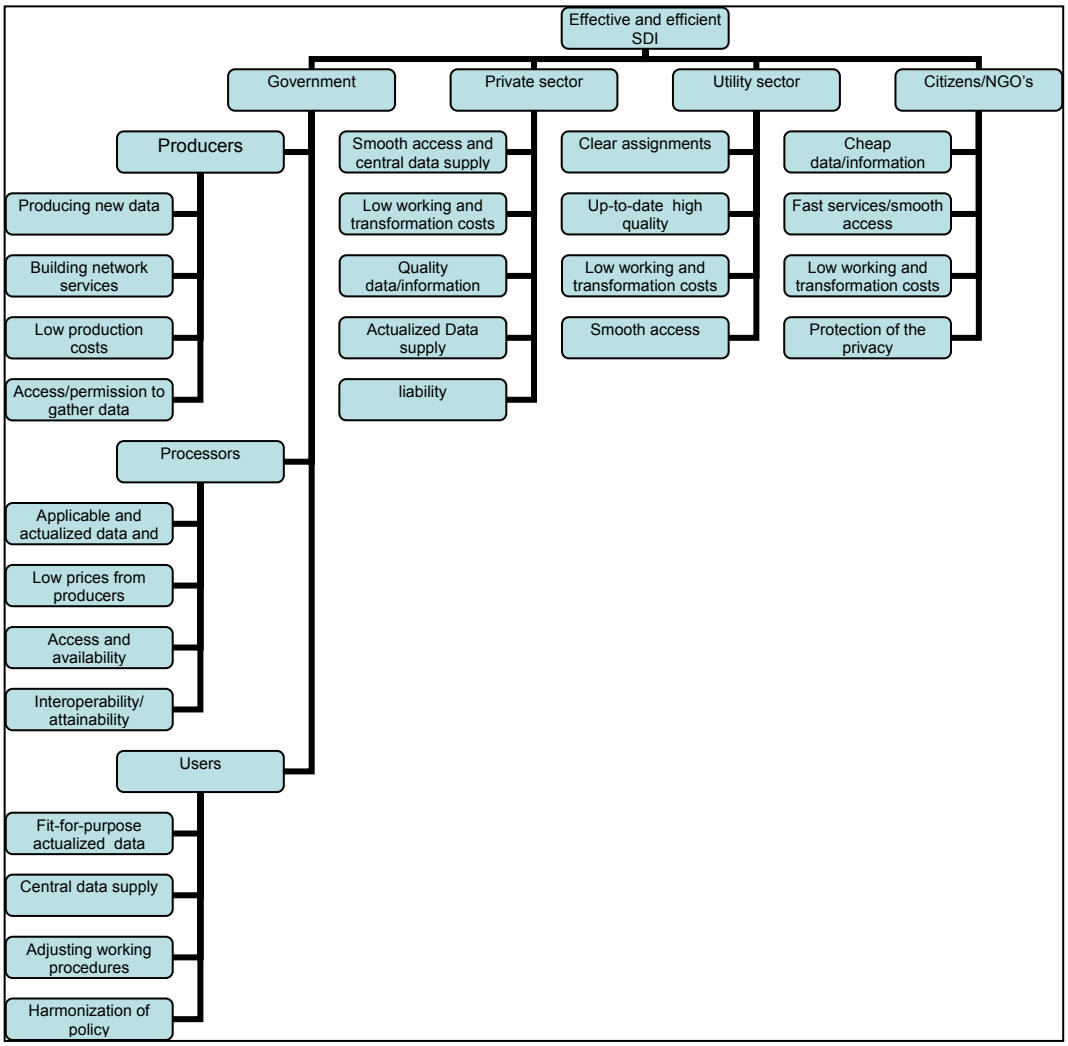
Knowing which aspects the stakeholders categorize as strengths and weaknesses is only the starting point. It is important to identify which of these aspects need the most attention: which weaknesses have to be tackled first, and which strengths are to be maintained or further developed? To get an idea of these priorities, the third question, where the stakeholders have to assign 100,000 euro to twelve possible SDI activities, is added to the questionnaire. Apparently, the highest investment priority for our stakeholders is the production

[1] http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/123/215

of new datasets. This might seem contradictory, since the high supply of geographical data that already exists in Flanders is considered to be one of the strengths of the infrastructure. However, these two results only reinforce each other and underline how important the availability of high quality geographical data is to the SDI stakeholders. Almost equally important is a more frequent update of the data. Other aspects high on the investment priority list are: a modification of existing working structures, the building of new applications and network services to support the policy and the coordinating organizations and a harmonization of existing datasets. Based on this information, a comparison can also be made between the diverse priorities of the "user" and the "producer" groups. Major differences exist for three investment posts, namely the production of new data, the modification of existing working procedures and the building of own network services. For the producers, the creation of new data is an absolute priority, while the users find this less important. The latter allocate a high amount to adjusting the existing working structures, an activity which the producers in their turn value less. Another priority for the producers is their own network services, which is only mentioned at the end of the line by the users. However, both groups agree on the high importance of better actualization policies for geographical data. Based on those three sources of information, a set of criteria is determined for each stakeholder group. An overview of these objectives of the different stakeholder groups, and thus simultaneously, the set of criteria for the MAMCA may be found in figure 2.

To verify the set of criteria, this list is sent, together with the different alternatives, the stakeholder classifications and an accompanying letter, to several key players of the SDI in Flanders namely: Agency for Geographical Information Flanders, National Geographic Institute, Coordination body Flemish e-government, Flemish Services for Government Policy, Association of Flemish provinces, Association of Flemish cities and municipalities, and the city of Leuven. They are asked to provide feedback on the proposed criteria. The analysts want to know if they agree with the criteria suggested, or if they would like to make adjustments or comments or maybe even propose different criteria. They are asked to state their opinions on the content and clearness of the different alternatives and the division of the SDI stakeholders into various groups as well. This enables the analysts to exploit the advantages of stakeholder participation and the iterative nature of the MAMCA from the beginning on. The cooperation with those key players which are all experts that function daily in the SDI in Flanders, will allow a clear and well-considered start-up framework for the MAMCA. These steps will be crucial for the rest of the procedure. Currently, those feed-backs are being gathered and the analysts are continuously optimizing the MAMCA framework. Once all the responses are obtained, the list of criteria stakeholders and alternatives will be finalized and used throughout the next steps of the MAMCA procedure.

Figure 2: Criteria of the different stakeholders



Another task yet to be completed in the third MAMCA step is the allocation of the criteria weights. In the MAMCA, this is also achieved in cooperation with the stakeholders. In this case study, the AHP method is used (Saaty, 1982). This method is chosen since the applied technique of pair wise comparing a number of elements to each other is straight forward and easily understandable for the stakeholders. Moreover, the AHP method is the best known and mostly applied MCA technique and its value and robustness has been proved many times throughout the years. In practice, the actors of the different stakeholder groups

are asked to compare the objectives (of their own group) to each other according to their contribution to the main objective. In order to state how much one objective contributes to the main objective in comparison to another, the specially designed nine point scale of the AHP method is used (Saaty, 1982). Afterwards, the AHP method uses calculating techniques based on the concepts of eigenvalues and eigenvectors to assign weights to the criteria which correspond best to these pair wise comparisons. The procedure of pair wise comparing criteria for assigning weights is not explained here in detail. Operative details on the AHP may be found in Saaty (1982).

6.5 Following steps of the MAMCA

Since the SDI is such a complex and multi-dimensional concept, the application of the MAMCA is also very time-consuming in this particular case study. The field work is still in progress or needs to be started up still for some steps. As mentioned above, the analysts are now assembling the feedback of the key players of the SDI in Flanders to be able to finalize the list of alternatives, stakeholders and criteria. After that, step four of the MAMCA procedure can start. Consequently, the following steps of the MAMCA applied in the SDI in Flanders context are only illustrated here briefly. Later on, they will be clarified in more detail.

In the fourth step, indicators and measurement methods are determined for each criterion. As mentioned earlier, one of the great advantages of MCA and MAMCA is that these methods do not require money values or quantitative data to conduct the analysis. It is possible to complete a MAMCA without using a single quantitative input; the method allows the analysts to obtain results based on almost any type of information. However, it is recommended to use quantitative data whenever possible, because the end results may become more tangible that way. When the indicators are determined, the measurement methods need to be established. After that, the gathering of the data, which is needed to conduct the analysis, may begin. This is a very complex task, which is performed by the analysts. To obtain this information, they may base themselves upon input from the stakeholders, specific experts, literature and so on. Afterwards, the analysts complete the true “mathematical” steps of the MAMCA. It is only in this phase, that the input of, and cooperation with the stakeholders happens just occasionally.

After the evaluation procedure and the mathematical calculations, the first results appear. At that time, the stakeholders have the chance to observe the outcome, all the alternatives and their scores on the different criteria. Afterwards, a sensitivity analysis might be performed in which the weights of the criteria as well as those of the stakeholders may be modified. This sensitivity analyses is very important, since the robustness of the results is tested. It is even possible that

these new insights give lead to the creation of extra alternatives or criteria which results in restarting the whole procedure. But once satisfaction is reached for those end results, it is time to incorporate them into the real policy making. This is where the former roles of the players of the MAMCA change completely. The analysts, that used to lead the whole procedure, now take a step back, since it are the policy makers that have to incorporate the results into actual SDI related strategies and decision making.

7 CONCLUSIONS

In the current SDI context, comprehensive and especially ex-ante assessments are rather scarce. When they do occur, they are usually focused on obtaining or motivating funding and hardly ever carried out for strategic objectives. Further, the same evaluation methods, such as Private Profitability (financial) Analysis and the Social Cost-Benefit Analysis are used in almost every problem context. However, these methods are not ideal in all circumstances and they both require monetary data for their calculations. This creates many difficulties, especially in the SDI context, where numerous different aspects and impacts are involved, where certainly not all effects are quantifiable and where diverse stakeholders have various backgrounds, needs and wishes.

This is why a different approach for the assessment of SDI policy strategies is presented in this paper, one that does not require solely monetary inputs, namely the Multi-Actor Multi-Criteria Analysis or MAMCA, which is an extension of the original Multi-Criteria Analysis or MCA. The MAMCA allows for structured and profound stakeholder participation during the entire evaluation procedure. The application of this method is innovative in the SDI context and might be valuable in the search for, and assessment of, new SDI policy strategies.

In this first paper, of a two-parted article, the application of the Multi-Actor Multi-Criteria Analysis (MAMCA) framework for assessing SDI policy strategies is proposed. To demonstrate such an analysis, the framework of the MAMCA for a case study on the assessment of possible policy strategies for the SDI in Flanders is presented. In the second paper, the following steps of this MAMCA case study will be clarified, together with the final outcomes and recommendations concerning the further development of the SDI in Flanders.

In this specific MAMCA case illustration, the most important stakeholders that are involved in the SDI environment in Flanders are: the government, the private sector, the utility sector and the citizens together with the NGO's. Their functions, and thus also their perceptions, needs and wishes related to the SDI, are not the same. The citizens want easy access to fit-for-purpose information at a low price, while the private sector wants to make a profit when selling products. The most complex role in these data infrastructures is the one of the government

departments. They function as data producers, processors and end users and above all this, they have to moderate the entire spatial data network and come up with solid and sustainable policy strategies. Their major priorities are the production and accessibility of actualized and valuable geographical data and information.

The methodology proposed in this paper provides a new assessment framework taking into account this complex decision making environment. It may guide the policymakers in their SDI related actions, allowing them to integrate the objectives of, and effects on, all the relevant actors in the SDI community.

Acknowledgements
The authors acknowledge the financial support by the Institute for the Promotion of Innovation by Science and Technology in Flanders (IWT), project Spatialist.

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